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Innovation and Export Competitiveness: Evidence from Flemish Firms

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ABSTRACT

We examine the effect of innovation on export intensity, export growth, and the geographic scope of exports, using cross-section and panel data on Flemish firms. The empirical results highlight that the introduction of innovations, and in particular product innovations, is an important driver of export intensity and export growth. These results are robust across different time periods in cross section analysis and in panel data analysis examining the impact of lagged innovations. Firms that persistently innovate record the highest export intensity and growth in export value, and the magnitude of the impact of innovation on export is sizeable. Firms introducing product innovations also show a significant broader geographic scope of exports, with a 10 percent point higher ratio of non-EU to EU destinations of exports. Once innovation is taken into account, smaller firms are no less successful in reaching non-EU export markets. The results suggest that policies to stimulate innovation and in particular product innovation are essential to stimulate export competitiveness.

1. INTRODUCTION

The development of export activities is a first step in the international growth strategy of firms. For firms based in small, open markets, expanding export activities and broadening the geographic scope of export activities is a necessity to continue growth. Research has shown that exporting firms have a higher survival rate and achieve greater employment growth compared with non-exporters (Bernard and Jensen, 1999; Muuls and Pisu, 2007). Important determinants of successful exports are investments in capital and technologies that lead to higher labor productivity, while the introduction of product innovations in particular is often associated with export decisions (Cassiman and Martinez-Ros, 2007; Becker and Egger, 2007). Hence, R&D and innovation, involving the introduction of new products or the improvement of a firm's existing product range, play a key role in helping a firm to sustain or improve its export market position.

In this paper we examine the relationship between innovation and export for Flemish firms. The Flemish economy is very export intensive and the region of Flanders accounts for 80 per cent of total Belgian exports (Flanders Investment and Trade, 2007). However, in recent years, Belgium has seen a decline of its share in world exports (Simonis, 2000), while the export orientation of firms has shown no increase (Onkelinx and Sleuwaegen, 2008). Given these facts and the importance of exports for the Flemish economy, surprisingly few studies have examined the determinants of Flemish or Belgian firms' export competitiveness. Using Belgian Central Bank data on firm-level export, Muuls and Pisu (2007) confirm a positive relationship between productivity and engagement in export. Bruneel et al. (2009) study the role of managerial experience and collaborative network relations with large enterprises in the export expansion of small Flemish firms. Onkelinx and Sleuwaegen (2008) compare characteristics of exporting and non-exporting firms in Belgium and find that exporting firm

tend to be larger and to reach higher labour productivity. Van Beveren and Vandenbusshe (2009) find that firms that start exporting activities reach higher productivity levels and have more often introduced product and process innovations, compared with firms that do not export.

This paper analyzes the effect of different types of innovation activities on the export competitiveness of Flemish firms. In contrast with most prior work that has focused on the decision to export, we examine the relationship between product and process innovations and the level of exports (export intensity). We draw on firm-level (panel) data from the Community Innovation Survey (CIS) for Flanders in the years 2000, 2004 and 2006. These surveys contain information on the value of exports of both innovating and non-innovating firms. We examine the relationship between product and process innovations and export intensity in each of the surveys, and the relationship between lagged and persistent innovation and export intensity in a panel of firms surveyed in all three years. Furthermore, the potential role of innovations in broadening the geographic scope of export activities is examined, and the impact of innovation on the growth of exports. The analyses control for other firm characteristics such as firm size, labor productivity, capital intensity, and whether the firm is part of a foreign or Flemish multinational group.

The remainder of the paper is organized as follows. The next section reviews prior literature on export competitiveness of firms, with an emphasis on the role of innovation. In section 3, we present cross-section analyses of export intensity, followed by an analysis of the effect of innovation on the geographic scope of exports. Section 4 presents the results of panel data analysis of the effect of lagged and persistent innovation on export intensity and export growth. Section 5 concludes.

2. LITERATURE REVIEW

Empirical research on export behaviour of firms has produced widespread evidence of a positive correlation between productivity and export performance (e.g. Aw and Batra, 1998, Bernard and Jensen, 1999). The literature has confirmed the notion that more productive firms self-select into export markets (e.g. Aw and Hwang 1995, Bernard and Jensen 1999, Bernard et al. 2007), i.e. a productivity advantage of the firm is required to enter foreign markets successfully. The notion that the most productive firms are mostly likely to start exporting activities builds on theoretical models developed by Melitz (2003) and is due to the existence of sunk setup costs of becoming an exporter (Roberts and Tybout, 1997), such as those related to information gathering on foreign markets and setting up overseas sales offices. While the empirical literature suggests that productivity drives exporting, there is much less robust evidence of a 'reverse' effect. Studies have presented mixed results for tests that firms 'learn by exporting' and are able to improve productivity through their export experience (Arnold and Hussinger 2005; Clerides et al., 1998; Bernard and Jensen, 1999; Delgado et al., 2002; Salomon and Shaver, 2005; Damijan et al, 2008).

The higher productivity of exporting firms is often related to firm-level technological advantages, due to R&D investments and the introduction of product and process innovations. Here a literature on the productivity effects of R&D has provided robust evidence (e.g. Crepon et al. 1998; Huergo and Jormandreu, 2004; Griffith et al., 2005). Since R&D and innovation is recognized as a driver for productivity, a large number of empirical studies have examined the relationship between exports and various input and output measures of innovation and technological capabilities. Early work focusing on firms' R&D expenditures or investments in new capital equipment (embodied technological change) has confirmed a

strongly positive relationship (e.g. Hirsch and Bijaoui, 1985; Belderbos and Sleuwaegen, 1998; Basile, 2000; Sterlacchini, 1999). Lefebvre et al. (1998) find that R&D collaboration with external partners is associated with greater export intensities. Sterlacchini (1999) suggests that in particular investments in product design activities and pre-production development efforts lead to export success.

A number of recent studies have explicitly focused on the effect of the introduction of product and process innovations on exports. There are several reasons why innovation will influence the internationalization of firms. First of all, product and process innovations may make it possible for firms to target new markets (Autio et al., 2000), as innovation efforts result in improved, modified or new products and/or process that may give enterprises a competitive advantage in foreign markets. Furthermore, innovative firms in small economies can only produce sufficient returns on R&D investments if they have a broad geographic market scope, which allows selling innovative products at a larger scale. In a study based on a sample of more than 1000 UK manufacturing firms, Wakelin (1997) and Wakelin (1998) confirmed that firms that introduced innovations were more export intensive and moreover less reliant on labor cost advantage to sustain exports. Using comparable plant-level surveys of UK and German firms, Roper & Love (2002) demonstrated a positive effect of product innovation on export in both countries. Becker and Egger (2007) using data on German firms, and Cassiman and Martinez-Ros (2007) using data on Spanish firms, conclude that product innovation is more important than process innovation for firms' propensity to engage in export activities. While product innovations are important for foreign market entry, process innovation may help maintain export positions once these have been established. Overall, the existing literature indicates that innovation is to be considered a major underlying force of exporting.

Exports from Flanders and Belgium

The Flemish economy is strongly dependent on exports. Nearly half of the population of firms located in Flanders or Brussels (with the exception of the construction sector) was engaged in export activities in 2002 (Onkelinx and Sleuwaegen, 2008). Among small and medium sized enterprises, Belgian firms are more internationally oriented than their counterparts in most other European countries (European Commission, 2004). A strong emphasis on foreign markets is due to the small home market and the resulting need to access growing and larger markets abroad (Onkelinx en Sleuwaegen, 2009). However, the export performance of Belgium and Flanders appears to be stagnating. Onkelinx and Sleuwaegen (2008, p. 66) found no increase in the export orientation among Belgian firms in recent years. Simonis (2000) showed a relative decrease of the world export share of Flanders, which is mainly due to the narrow scope of Belgian exports to countries of the European Union. The main trade partners of Flanders are its neighbouring countries Germany, the Netherlands and France (Flanders Investment and Trade, 2007; Muuls en Pisu, 2007). Exports from Flanders have therefore not benefited from market expansion in growing economies in Asia and South America. Gielens et al. (1998) in this regard, confirms that geographic distance remains an important barrier to Belgian exports. In one of the few large scale studies of exporting by Belgian firms, Muuls and Pisu (2007) confirm that firms with higher productivity are most likely to overcome barriers to export and start exporting. This relationship is particularly strong for exporting to developed countries. Van Beveren and Vandenbussche (2009), using Belgian CIS data, confirm the role of productivity and also find weak evidence for a positive effect of the introduction of product and process innovations on the start of export activities.[1]

[1] This result no longer held as significant in alternative specifications using instrumental variable methods.

This paper contributes an in-depth analysis of the relationship between innovation and export competitiveness for Flemish firms. We draw on firm-level (panel) data from the Community Innovation Survey (CIS) for Flanders in the years 2000, 2004 and 2006. These surveys contain information on the value of exports of both innovating and non-innovating firms. In contrast with most prior work that has focused on the decision to export, we examine the relationship between product and process innovations and the level of exports (export intensity). Furthermore, we examine the potential role of innovations in broadening the geographic scope of export activities – an important issue for the Flemish economy – and the impact of innovation on the growth of exports. The analyses control for other firm characteristics such as firm size, labor productivity, capital intensity, and whether the firm is part of a foreign or Flemish multinational group.

3. DETERMINANTS OF EXPORT INTENSITY AND THE GEOGRAPHIC SCOPE OF EXPORTS: CROSS SECTION ANALYSIS

We analyze the relationship between exporting and innovation by drawing on the Community Innovation Survey (CIS) for Flanders (CIS3, CIS4 and CIS5). The CIS3 survey covers the years 1998 to 2000 (1008 firms); the CIS4 survey relates to the years 2002 to 2004 (1155 firms) and the CIS5 questionnaire refers to the years 2004 to 2006 (1330 firms). The surveys includes all larger firms in Flanders (firms with more than 250 employees) and a stratified sample of smaller firms with at least 10 employees. The CIS survey identifies firms as innovative if at least one out of four criteria is met: the firm (a) has launched a new or improved product on the market, (b) has realized new or improved processes, (c) was involved in innovation activities that are still ongoing, or (d) was involved in innovation activities that have been untimely aborted. In each survey, a question is included on the value

of exports or the export intensity of the firm. We merged the CIS data to information on yearly corporate accounts from the ISF database, which draws on the Belfirst database published by Bureau van Dijk. Information on the presence of innovating and exporting firms in the different surveys is presented in table 1. On average 60-78 percent of the sample firms are exporters, while 70-76 percent of the sample firms innovate. Among innovators more than 80 percent is exporting, while among exporters, the percentage of innovators is less high in the last two surveys (66-68) percent.

INSERT TABLE 1

In a first series of analysis, we examine the relationship between export intensity (the percentage of exports in total sales) and different types of innovation through cross-section analyses for the three different surveys. This allows investigating the robustness of these relationships over time. The analysis includes four indicators of innovation activity as dummy variables: 1) the firm introduced both product and process innovation, 2) the firm introduced only product innovation, 3) the firm introduced only process innovation, 4) the firm is engaged in innovation efforts that have not led to product or process innovation in the surveyed period The benchmark (omitted dummy variable) are firms with no innovation efforts.

As recommended by prior studies on the determinants of exports (Wagner, 2007), we include a range of control variables. One such additional variable is firm size (the natural logarithm of the number of employees). Firm size is expected to have a positive relationship with export intensity as larger firms have more resources to bear the costs of foreign market entry. A higher capital intensity (fixed assets per employee) of a firm is likely to make it more export competitive as capital goods may embody improved technology, while capital intensive

production is consistent with the comparative advantage of developed countries (Belderbos and Sleuwaegen, 1998). Labor productivity (value added per employee) is included to control for the competitive advantage related to productivity found in the empirical literature. Firm age may have a complex relationship with exporting (Arnold & Hussinger, 2005; Wagner, 2007), with young inexperienced firms less likely to export, but with older firms perhaps suffering from less dynamism and a 'liability of adolescence' (Hannan, 1998). The analysis controls for firm age by including both the natural logarithm of firm age (number of years since foundation) and the square of this logarithm. The analysis also takes into account collaboration in R&D as a potential attribute of innovation activity relevant for exporting. In particular collaboration with foreign partners on R&D may be associated with greater export performance, as this R&D may be directed at the adaptation of products and processes to meet foreign market specifications. The analysis includes two dummy variables: domestic R&D cooperation, taking the value 1 if the firm indicates to have collaborated with domestic partners, and foreign R&D cooperation, taking the value 1 if the firm indicates to have collaborated with foreign partners. The survey also identifies firms that are owned by another (parent) firm and contains information on whether this parent firm is based abroad. This allows us to indentify foreign owed affiliates. In the CIS5 survey, in addition, a question was included on foreign affiliates of the firms, which allows identification of Flemish multinational firms. The analyses include dummy variables for foreign multinational and domestic. Finally, we include a set of 19 industry dummies to control for heterogeneity across sectors. Table 2 includes the description, mean and standard deviation for each variable per cross section. The average export intensity for the three samples is 39% (2000), 31% (2004) and 35% (2006).

INSERT TABLE 2

Further insights are obtained when we differentiate variable means by innovation type (table 3). Firms that introduced both product and process innovations show the highest export intensities (47-49 percent). Firms focusing on product innovations have the highest labor productivity but are smaller on average than firms engaged in process innovations or product & process innovations. Non-innovating firms are on average smaller, less productive, less capital intensive, and smaller than innovating firms.

INSERT TABLE 3

Since the dependent variable, export intensity is restricted to the interval [0,1] we apply a tobit model to relate export intensity to the explanatory variables. The tobit model is more appropriate than an OLS model when the dependent variable has a large number of observations at the lower limit (non-exporting firms). OLS estimates are then biased downward and may predict values of the dependent variable outside the possible range. We estimate a first model with innovation (the firm is active in innovation activities) as independent variable. We then separate the innovation variable into the 4 different categories: (1) product and process innovation, (2) only product innovation, (3) only process innovation, (4) other innovation efforts. We repeat this for the available cross sections (2000, 2004 and 2006).

INSERT TABLE 4

Table 4 reports the results of the cross section analyses. The empirical results are all very comparable across the years. Innovating firms are significantly more export intensive than non- innovating firms. When we differentiate between the types of innovation, all innovation activities have a positive and significant effect on export intensity, while the coefficients are

highest for firms that introduced product innovations, combined or not combined with process innovations. The other estimates show that export intensity is also positively related to the size of the firm, labor productivity, capital intensity, and foreign R&D cooperation. Firm age shows a curvilinear effect in some specifications, suggesting that age is associated with higher export intensity for younger firms, while the very mature firms again have lower export intensities. Affiliates of foreign multinational firms have significantly higher export intensities, but the largest impact of multinationality is found for Flemish multinationals (2006).

INSERT TABLE 5

In order to interpret the magnitude of the impact of innovation on export intensity we use the decomposition suggested by McDonald and Moffitt (1980). The total marginal effect, $\delta E(y)/\delta x$, is disaggregated into two marginal effects: the first is the effect on the probability that the firm is an exporter, and the second the effect on the export intensity given that the firm exports. Table 5 shows these marginal effects. Innovation leads to a 12 (for 2000), 13 (for 2004) and 10 (for 2006) percent point increase in the probability to export. Product innovation in particular has the strongest effect, while process innovation has the smallest impact. The marginal effects on the export intensity, conditional on the fact that the firm is an exporter, are somewhat smaller in magnitude but still quite substantial. Again, product innovation leads to the strongest increase in export intensity, either combined with process innovations or not. The order of magnitude of the effect ranges between an 8 and 11 percent point increase in the export intensity.

Determinants of Geographic Export Scope

For the survey in the year 2006 we examine the determinants of export scope, i.e. the extent to which a firm is engaged in exports to countries outside the European Union. The dependent variable is the ratio of non-European export over total export. Since we only take exporting firms into account, the sample size is reduced to 977 observations. Table 4 presents the results of the tobit regression. The results show that innovation and in particular product innovation is an important driver of broadening the export base to non-European countries. In contrast, no significant effect on export scope is found of the introduction of process innovations only. The other variables with a significant effect are labor productivity and capital intensity. There is a strong significant effect for Flemish (domestic) multinational firms, but affiliates of foreign multinational firms do not have a greater geographic scope of exports, ceteris paribus. In addition, smaller firms are, perhaps surprisingly, not less likely to export to non-EU destinations than larger firms, once we control for innovation.

4. DETERMINANTS OF EXPORT INTENSITY AND EXPORT GROWTH: PANEL DATA ANALYSIS

Since there may be a concern that exports and innovation activities are simultaneously determined or that exports may have a reverse effect on innovation activities, we construct a panel dataset and examine the impact of lagged innovation activities on current export intensity. Furthermore we examine whether firms that are persistently innovating have a higher export intensity. To test the impact of lagged and persistent innovation, the sample has to be restricted to firms that are reporting in two or more consecutive surveys. Table 6 provides information on the structure of the resulting (unbalanced) panel data set. The dataset

contains 733 observations: 272 firms appear both in the surveys of 2000 and 2004, and 461 firms appear in the surveys of 2004 and 2006. Among these firms that can be observed in consecutive surveys, 133 are present in all three surveys and appear twice as observations in the panel. In the sample of 733 observations, 215 firms innovate persistently in 2000 and 2004 while 295 firms innovate persistently in 2004 and 2006. Among the remaining firms, 85 only report to have introduced innovations in the prior survey and 71 report only current innovation (but no lagged innovation). We will compare the effects of lagged, current, and persistent innovation in the panel data analyses.

INSERT TABLE 6

In order to be able to examine the effects of lagged innovation on export intensity, we introduce 5 dummy variables; lagged innovation, lagged product & process innovation, lagged product innovation only, lagged process innovation only, and lagged other innovative activities. If the firm was engaged in such innovative activities in the prior survey, the related dummy variable takes the value 1. Table 7 shows means and standard deviations for the variables used in the estimation. These are similar to the variables used in the cross section analysis, but are lagged either by taking values from the prior CIS survey or by taking one year lagged values from the ISF-Belfirst data (e.g. capital intensity, labor productivity).

INSERT TABLE 7

Table 8 presents characteristics of innovating firms, distinguishing persistent, lagged, and current innovators. Firms that are persistently innovating have the highest export intensity, growth in the value of exports, and are on average larger, more productive and more capital intensive then non- innovative firms. If the group of firms is broadened to those with lagged

innovation, but not necessarily persistent innovation, export intensity and export growth are somewhat lower. In contrast, firms with only lagged (but no current) or only current (but no lagged) innovation are much less export intensive and firms with only lagged innovation even have negative export growth on average. These statistics suggest the importance of persistent innovation. Among the types of innovation, it is again lagged product innovation, combined or not combined with process innovation, that is associated with the highest export intensities, while firms with lagged product innovation have the strongest export growth.

INSERT TABLE 8

We estimate the impact of lagged innovation on export intensity using a random effects tobit model to control for unobserved firm heterogeneity. Fixed effects models are not available for tobit models and the use of them would reduce the sample for estimation from 733 to 133 firms due to the unbalanced nature of the panel data set. We estimate four models. The first model has lagged innovation as regressor. In a second model we make a distinction between lagged innovation for firms in 2006 and 2004, respectively, to examine whether the different lags between the surveys (2 years for observations in 2006 and 4 years for observations in 2004) have different implications for the effect of innovation. In the third model, we distinguish the four different categories of lagged innovation: (1) product and process innovation, (2) only product innovation, (3) only process innovation, and (4) other innovation efforts. In the final model, we distinguish different lag structures for innovation: firms with persistent innovation, firms with only current innovation activities, and firms with only lagged innovation.

INSERT TABLE 9

The results of the random effects tobit model of export intensity are presented in Table 9. Lagged innovation is highly significant (model 1), and the difference between two and four years lagged innovation is negligible (model 2). All different types of lagged innovation have a significant effect on export intensity (model 3), with the highest coefficient estimated for joint product and process innovation, followed by product innovations only. The coefficients estimated in model 4 show clearly that it is persistent innovative effort that is most strongly affecting export intensity: the coefficient is twice as large as the coefficient for only lagged innovation. Firms with only current innovation activities furthermore, do not have a significantly larger export intensity than firms that have not been engaged in innovation efforts at all. Sign and significance of the (lagged) control variables are in most cases similar to the cross section analyses in Table 4. Firm size, labor productivity, and capital intensity have a positive effect, and affiliates of foreign multinational firms have a significantly greater export intensity. Firms that have been engaged in domestic R&D collaboration show a significantly lower export intensity, while lagged foreign R&D collaboration does not have a significant effect here.

INSERT TABLE 10

The marginal effects of the main explanatory variables of interest are presented in table 10. The calculated marginal effects for persistent and lagged innovation are higher than the marginal effects of innovation in the cross section analyses. Lagged innovation increase the probability of export by 14 percent points, while the export intensity for exporting firms is increased by 11 percent points. These percentages are substantially higher for persistent innovation, at 21 and 16 percent points, respectively. Firms that only introduced innovations in the past but are not active in current innovation activities have a 6 percent points higher probability of export and a 5 percent point higher export intensity compared with firms that

are not active in innovation at all. Overall the above findings stress the importance of persistent innovation.

Determinants of export growth

We also examine the effect of lagged and persistent innovation on the growth of the export value, as export expansion is one of the main challenges for Flemish firms. We restrict the sample to those firms that are exporting in two consecutive years and calculate the proportional growth in the value of exports as the difference in the natural logarithm of exports in two consecutive years: ln (export(t)) – ln(export(t-1)).[2] We estimate a random effects model explaining the growth in exports using the same right hand side variables as in the export intensity analysis. The results are reported in Table 11. The estimated coefficients show large effects of innovation on export growth. Lagged innovation increases the export growth by 148 percent points. The effect of lagged innovation is highest if it concerns product innovation only (193 percent). The largest impact is again found for persistent innovation, which is associated with more than a tripling of exports (228 percent growth), while only lagged innovation is associated with a doubling of exports. In contrast, only current innovation effort does not have a significant impact on export growth. Among the control variables, a greater lagged export value is associated with lower growth, as it is more difficult to achieve the same proportional growth in exports at higher initial values. Firm size, productivity, and capital intensity are positively associated with export growth, but R&D collaboration and foreign ownership have no significant effects.

INSERT TABLE 11

[2] Mean and standard deviation of this variable are included in Table 6.

5. CONCLUSIONS

The Flemish economy is strongly dependent on export, but in recent years world export shares have been declining, while exports remain highly dependent demand in the EU, and in particular in neighboring countries. Against this background, this paper analyzes the determinants of export intensity, export growth, and the geographic scope of exports, using cross-section and panel data on Flemish firms. The focus is on the role of innovation and the analysis distinguishes between different types of innovations: product, process, and other innovation activities. The empirical analyses controls for a range of other firm characteristics such as labour productivity, capital intensity, firm size, multinationality and industry, in order to obtain more precise insights into the importance of innovation for export success.

The empirical results highlight that the introduction of innovations, and in particular product innovation, is an important driver of export intensity and export growth. Firms that introduce only process innovations also export more but the magnitude of this effect is smaller. The results are robust across different time periods in cross section analysis and in panel data analysis examining the impact of lagged innovation on export intensity and export growth. The largest effect is found for firms that persistently innovate. The magnitude of the impact of innovation on export intensity is sizeable: the probability to export is increased by up to 20 percent points, the export intensity of exporters increases by up to 16 percent points, while the value of exports can more than triple over a two to four year period.

Firms introducing product innovations also show a significant broader geographic scope of exports, with the ratio of non-EU to EU destinations of exports increased by 10 percent points. Once innovation is taken into account, smaller firms are no less successful in reaching non-EU export markets than larger firms. While affiliates of foreign multinational firms are

generally more export intensive than Flemish owned firms, the scope of their exports is not broader. Flemish multinational firms (firms with foreign affiliates) do achieve a significantly greater share of non-EU destinations in their exports. This suggests that the establishment of foreign affiliates may facilitate export expansion through improved marketing efforts, access to distribution networks, and after sales service (e.g. Belderbos and Sleuwaegen, 1998).

Our results emphasize the important role of innovation as a major driver of export performance of Flemish firms. The findings confirm results of earlier studies, suggesting that in particular new product introductions and product upgrading are often necessary for export competitiveness and the penetration of foreign markets as firms seek to adapt their products to foreign market conditions and demand (e.g. Bernard et al. 2007). The implication of the findings is that policies to stimulate persistent innovation efforts, and in particular product innovation, are essential to stimulate export competitiveness and may serve as one of the most effective export promotion policies.

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TABLE 1: Exporters and Innovators in the cross section analyses

Year	2000	2004	2006
Sample size	1008	1155	1330
Exporters (% of total)	785 (78%)	656 (57%)	816 (61%)
Innovating firms (% of total)	767 (76%)	808 (70%)	977 (73%)
% exporters among innovators	85%	82%	82%
% innovators among exporters	83%	66%	68%

TABLE 2: Variable definitions: cross section analysis

Variable Name	Description	2000		2004		2006	
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Export intensity	Ratio of export over turnover	0.39	0.36	0.31	0.36	0.35	0.37
Non- European export	non- EU export / total export	/	/	/	/	0.15	0.24
Innovation	Dummy variable equal to 1 if the company is involved in innovation activities and equal to 0 if not.	0.76	0.43	0.57	0.49	0.62	0.48
Product innovation	Dummy variable equal to 1 if a firm introduces innovation only in product; and equal to 0 if not.	0.13	0.33	0.14	0.34	0.13	0.34
Process innovation	Dummy variable equal to 1 if firm introduces innovation only in process; and equal to 0 if not.	0.17	0.38	0.11	0.31	0.12	0.33
Product & Process innovation	Dummy variable equal to 1 if firm introduces innovation in process and product; and equal to 0 if not.	0.40	0.49	0.26	0.44	0.28	0.45
Other Innovation	Dummy variable equal to 1 if the firm is acvtive in other kinds of innovation.	0.05	0.22	0.06	0.24	0.07	0.26
Firm size	Logarithm of the number of employees	1.55	0.73	1.47	0.70	1.56	0.69
Labour productivity	Natural logarithm of the ratio of value added over total employment	4.03	0.51	4.07	0.56	4.19	0.47
Capital intensity	Natural logarithm of the ratio of fixed assets over total employment	2.26	1.54	2.35	1.62	2.29	1.48
Domestic R&D collaboration	Dummy indicating firms cooperating on R&D with domestic partners	0.23	0.51	0.26	0.53	0.36	0.61
Foreign R&D collaboration	Dummy indicating firms cooperating on R&D with foreign partners	0.15	0.39	0.22	0.52	0.28	0.59
Foreign multinational firms	Dummy indicating affiliate of foreign multinational firms	0.27	0.45	0.23	0.42	0.26	0.44
Domestic multinational firms	Dummy indicating if the firm is a domestic multinational	/	/	/	/	0.05	0.21
Age	Natural logarithm of (1+ years since foundation)	4.13	0.45	2.99	0.9	3.15	0.89
Age^2	Square term of Age	17.32	3.06	9.79	5.34	10.68	5.36

TABLE 3: Average characteristics of firms with and without innovation

Year 2000	No innovation (n=257)	Product and process innovation (n=431)	Product innovation (n=135)	Process innovation (n=185)
Variables	Mean	Mean	Mean	Mean
Export intensity	0,23	0,49	0,39	0,38
Size	1,22	1,78	1,47	1,54
Age	4,16	4,13	4,18	4,10
Labour productivity	3,91	4,09	4,11	3,98
Capital intensity	1,86	2,41	2,44	2,2
Domestic R&D cooperation	0,02	0,9	0,54	0,28
Foreign R&D cooperation	0,02	2,13	0,83	0,55
Foreign multinational firms	0,14	0,31	0,32	0,33
Year 2004	No innovation (n=608)	Product and process innovation (n=357)	Product innovation (n=168)	Process innovation (n=154)
Variables	Mean	Mean	Mean	Mean
Export intensity	0,17	0,47	0,43	0,35
Size	1,26	1,76	1,57	1,60
Age	2,93	3,09	3,09	3,00
Labour productivity	3,98	4,12	4,22	4,14
Capital intensity	2,08	2,68	2,57	2,47
Domestic R&D cooperation	0	2,91	1,59	1,13
Foreign R&D cooperation	0	2,87	1,38	0,8
Foreign multinational firms	0,17	0,31	0,28	0,23
Year 2006	No innovation (n=578)	Product and process innovation (n=443)	Product innovation (n=203)	Process innovation (n=194)
Variables	Mean	Mean	Mean	Mean
Export intensity	0,23	0,47	0,4	0,34
Size	1,41	1,81	1,51	1,57
Age	3,13	3,19	3,00	3,18
Labour productivity	4,09	4,26	4,29	4,16
Capital intensity	2,02	2,4	2,65	2,34
Domestic R&D cooperation	0	1,75	1,27	0,82
Foreign R&D cooperation	0	1,69	0,97	0,59
Foreign multinational firms	0,23	0,31	0,29	0,22

TABLE 4: Tobit estimates of the determinants of export intensity (2000/2004/2006) and the share of exports to non- EU countries (2006)

	Export intensity						Share of non- EU export in total export	
	2000		2004		2006		2006	
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Innovation	0.15***		0.19***		0.14***		0.12***	
	(0.03)		(0.03)		(0.03)		(0.04)	
Types of innovation								
Product & Process		0.19***		0.20***		0.16***		0.11***
		(0.04)		(0.03)		(0.03)		(0.04)
Only product		0.12***		0.23***		0.17***		0.151***
		(0.04)		(0.04)		(0.04)		(0.05)
Only process		0.11***		0.13***		0.08**		0.08
		(0.04)		(0.04)		(0.04)		(0.05)
Other innovation		0.12*		0.16***		0.16***		0.16***
		(0.06)		(0.05)		(0.05)		(0.06)
Other company characteristics:								
Size	0.06***	0.05***	0.06***	0.06***	0.04*	0.04*	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Productivity level	0.12***	0.12***	0.12***	0.12***	0.17***	0.16***	0.10***	0.09***
	(0.03)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)
Capital intensity	0.02**	0.02**	0.05***	0.05***	0.03***	0.03***	0.02*	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Domestic R&D cooperation	-0.01	-0.01	-0.11***	-0.11***	0.01	0.01	-0.00	-0.00
	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.03)	(0.03)	(0.03)
Foreign R&D cooperation	0.11***	0.10**	0.19***	0.18***	0.09***	0.09***	0.03	0.03
	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Age	0.01*	0.01*	0.07	0.06	-0.03	-0.03	-0.06	-0.05
	(0.00)	(0.00)	(0.07)	(0.07)	(0.08)	(0.08)	(0.11)	(0.11)
Age^2	-0.04*	-0.03*	-0.01	-0.01	0.01	0.01	0.02	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Foreign multinational	0.13***	0.14***	0.10***	0.10***	0.12***	0.12***	0.04	0.04
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Domestic multinational					0.25***	0.24***	0.15***	0.14**
					(0.05)	(0.05)	(0.05)	(0.06)
Industry dummies	Included	Included	Included	Included	Included	Included	Included	Included
Constant	-0.77***	-0.76***	-0.91***	-0.91***	-0.87***	-0.86***	-0.76***	-0.75***
	(0.15)	(0.15)	(0.15)	(0.15)	(0.18)	(0.18)	(0.23)	(0.23)
Observations	1008	1008	1155	1155	1330	1330	977	977
Log Likelihood	-546.41	-542.79	-612.85	-610.55	-816.79	-814.19	-543.37	-542.27
Wald Chi2	350.3	357.54	561.86	566.46	423.17	428.36	163.69	165.88
Pseudo R^2	0.24	0.25	0.31	0.32	0.21	0.21	0.13	0.13

Notes: Robust standard errors in parentheses; *** significant at 1%, ** at 5%,* at 10% level

TABLE 5: Decomposition of the marginal effects of innovation on export

	Probability of export (Yes/No)	Propensity of export for exporting firms (only>0)
For the year 2000		
Innovation	0,12	0,08
Product & process innovation	0,15	0,11
Only product innovation	0,10	0,07
Only process innovation	0,09	0,06
Other innovation efforts	0,09	0,07
For the year 2004		
Innovation	0,13	0,09
Product & process innovation	0,14	0,10
Only product innovation	0,16	0,11
Only process innovation	0,09	0,06
Other innovation efforts	0,11	0,08
For the year 2006		
Innovation	0,10	0,07
Product & process innovation	0,12	0,08
Only product innovation	0,12	0,09
Only process innovation	0,06	0,04
Other innovation efforts	0,11	0,08

TABLE 6: Structure of the panel data set and innovation patterns, 2000-2006

total observations	733
Firms appearing both in 2000 & 2004	272
Firms both in 2004 & 2006	461
Firms appearing in 2000, 2004 & 2006	133
Firms with lagged innovation	510
Firms with persistent innovation (lagged and current innovation)	425
Firms with only lagged innovation but no current innovation	85
Firms with current innovation but no lagged innovation	71
Firms with no innovation efforts	152

TABLE 7: Definitions and descriptives of variables; panel dataset

Name	Description	Mean	Std. Dev
Export intensity	Ratio of export over turnover	0.35	0.36
Growth of the export value	Proportional growth in exports = ln(export(current)) – ln(export(prior survey))	0.39	4.15
Lagged innovation	Dummy variable equal to 1 if the company was involved in past innovation activities (such as R&D, innovation projects, successful introduction of innovation); and equal to 0 if not, prior survey	0.69	0.46
Lagged product & process innovation	Dummy variable equal to 1 if firm introduced innovation in both product & process; and equal to 0 if not, prior survey	0.36	0.48
Lagged product innovation only	Dummy variable equal to 1 if firm introduced innovation only in product; and equal to 0 if not, prior survey	0.14	0.35
Lagged process innovation only	Dummy variable equal to 1 if firm introduced innovation only in process; and equal to 0 if not., prior survey	0.12	0.33
Other lagged innovative activities	Dummy variable equal to 1 if firm was engaged in innovation activities but did not introduce product or process innovations., and equal to 0 if not, prior survey	0.06	0.24
Firms with persistent innovation	Dummy variable equal to 1 if firm was engaged in innovation activities during consecutive years	0.57	0.49
Firms with only lagged innovation	Dummy variable equal to 1 if firm was engaged in innovation activities during consecutive years but is not active in current innovation	0.13	0.33
Firms with only current innovation	Dummy variable equal to 1 if firm was not engaged in innovation activities during consecutive years but is active in current innovation	0.09	0.29
Firms with no innovation	Dummy variable equal to 1 if firm was not engaged in innovation activities during consecutive years but is not active in current innovation	0.20	0.40
Firm size	Natural Logarithm of the number of employees, t-1	1.53	0.7
Lagged Labour productivity	Natural logarithm of the ratio of value added over employment t-1	4.11	0.52
Lagged Capital intensity	Natural logarithm of the ratio of fixed assets over employment t-1	2.3	1.54
Lagged Domestic R&D collaboration	Dummy indicating firms cooperating on R&D with domestic partners, prior survey	0.29	0.56
Lagged Foreign R&D collaboration	Dummy indicating firms cooperating on R&D with foreign partners, prior survey	0.22	0.52
Foreign multinational firms	Dummy indicating affiliate of foreign multinational firms	0.25	0.43
Age	Natural logarithm (1+ years since founding)	2.98	0.76
Age^2	Square term of Age	9.47	4.25

Note: prior survey is t-2 (for observations in 2006) or t-4 (for observations in 2004)

TABLE 8: Characteristics of innovation firms: panel dataset

variables	Persistent innovation (n=425) Mean	Mean	Current innovation only (n=71) Mean	Std.Dev	Only lagged innovation (n=85) Mean	Std.Dev	No innovation activities (n=152) Mean	Std.Dev
Export intensity	0.55	0.55	0,25	0,31	0.29	0,33	0,20	0,31
Growth of the export value	0.62	0.62	0.53	5.19	-0.12	4.66	0,04	4.88
Size of the firm	1,87	1,87	1,34	0,65	1,27	0,51	1,23	0,5
Lagged labor productivity	4,29	4,29	4,14	0,41	4,09	0,42	4,02	0,46
Lagged capital intensity	2,54	2,54	2,22	1,27	2,34	1,28	1,99	1,45
Lagged domestic R&D cooperation	0,65	0,65	0	0	0,02	0,47	0	0
Lagged foreign R&D cooperation	0,61	0,61	0	0	0,11	0,35	0	0
Foreign multinational firms	0,32	0,32	0,20	0,41	0,23	0,42	0,14	0,35
Age	3,32	3,32	3,37	0,66	3,22	0,69	3,14	0,71
variables	lagged product & process innovation (n=265) Mean	Std.Dev	lagged product innovation (n=105) Mean	Std.Dev	lagged process innovation (n=92) Mean	Std.Dev	other lagged innovation efforts (n=48) Mean	Std.Dev
Export intensity	0,54	0,37	0,5	0,36	0,43	0,37	0,42	0,38
Growth of the export value	0.24	3.43	0.95	4.31	0.68	3.69	0.63	3.80
Size of the firm	1,9	0,84	1,64	0,73	1,66	0,79	1,27	0,57
Lagged labor productivity	4,27	0,46	4,32	0,48	4,17	0,43	4,14	0,48
Lagged capital intensity	2,62	1,52	2,46	1,36	2,26	1,47	2,52	1,61
Lagged domestic R&D cooperation	0,61	0,71	0,32	0,58	0,28	0,49	0,19	0,44
Lagged foreign R&D cooperation	0,53	0,68	0.26	0,52	0,13	0,36	0,06	0,23
Foreign multinational firms	0,32	0,47	0,29	0,45	0,28	0,45	0,23	0,42
Age	3,16	0,65	3,11	0,65	3,27	0,52	3,06	0,69

TABLE 9: Random effects tobit model of the determinants of export intensity, 2004-2006

	Model 1	Model 2	Model 3	Model 4
	coef./std.error	coef./std.error	coef./std.error	coef./std.error
Lagged innovation	0.10***			
	(0.02)			
Lagged innovation 2006		0.10***		
		(0.03)		
Lagged innovation 2004		0.10***		
		(0.02)		
Persistent innovation				0.21***
				(0.03)
Only current innovation				0.07*
				(0.03)
Only lagged innovation				0.09***
				(0.03)
Lagged product and process			0.12***	
			(0.03)	
Lagged only product			0.11***	
			(0.03)	
Lagged only process			0.10***	
			(0.03)	
Lagged innovation efforts			0.08**	
			(0.03)	
Lagged firm size	0.06***	0.06***	0.05***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)
Lagged labor productivity	0.12***	0.12***	0.11***	0.12***
	(0.03)	(0.03)	(0.03)	(0.02)
Lagged capital intensity	0.05***	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)
Lagged domestic R&D cooperation	-0.05**	-0.05**	-0.05**	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)
Lagged foreign R&D cooperation	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Foreign multinational firms	0.09***	0.09**	0.09**	0.08**
	(0.03)	(0.03)	(0.03)	(0.03)
Age	-0.35**	-0.35**	-0.36**	-0.37**
	(0.16)	(-0.16)	(0.16)	(0.16)
Age^2	0.05**	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)
Industry dummies	Included	Included	Included	Included
Constant	0.06	0.05	0.08	0.04
	(0.28)	(0.28)	(0.28)	(0.28)
Observations	733	733	733	733
Log likelihood	-245.66	-245.68	-244.38	-236.65
Wald chi2	321.83	306.11	350.97	333.13

Notes: Robust standard errors in parentheses
*** significant at 1%, ** at 5%,* at 10% level

TABLE 10: Decomposition of the marginal effects of innovation on export intensity

	Probability of export (Yes/No)	Export intensity for exporting firms
Lagged innovation	0.14	0.11
Persistent innovation	0.21	0.16
Lagged innovation only	0.06	0.05
Lagged product and process	0.15	0.12
Lagged product innovation only	0.18	0.14
Lagged process innovation only	0.13	0.10
Lagged innovation efforts	0.09	0.07

TABLE 11: Random effects model of the determinants of export growth

	Model 1	Model 2	Model 3	Model 4
	coef./std.error	coef./std.error	coef./std.error	coef./std.error
Lagged innovation	1.48***			
	(0.37)			
Lagged innovation 2006		1.43***		
		(0.42)		
Lagged innovation 2004		1.59**		
		(0.58)		
Persistent innovation			2.28***	
			(0.46)	
current innovation only			0.74	
			(0.56)	
lagged innovation only			1.02*	
			(0.54)	
Lagged product and process				1.24**
				(0..43)
Lagged product innovation only				1.93***
				(0.48)
Lagged process innovation only				1.67**
				(0.52)
Lagged innovation efforts				1.09*
				(0.61)
Ln (lagged export value)	-0.42***	-0.42***	-0.43***	-0.42***
	(0.03)	(0.03)	(0.3)	(0.29)
Lagged firm size	0.51***	0.52***	0.43***	0.53***
	(0.15)	(0.15)	(0.15)	(0.15)
Lagged labor productivity	0.72*	0.75**	0.69*	0.70*
	(0.38)	(0.39)	(0.38)	(0.38)
Lagged capital intensity	0.36***	0.36***	0.37***	0.37***
	(0.12)	(0.12)	(0.12)	(0.12)
Lagged domestic R&D cooperation	-0.33	-0.34	-0.39	-0.34
	(0.32)	(0.32)	(0.32)	(0.32)
Lagged foreign R&D cooperation	-0.03	-0.01	-0.02	0.04
	(0.37)	(0.37)	(0.37)	(0.37)
Foreign multinational firm	-0.11	-0.12	-0.07	-0.11
	(0.41)	(0.41)	(0.41)	(-0.28)
Age	-1.18	-1.20	-1.08	-1.34
	(1.89)	(1.89)	(1.87)	(-0.69)
Age^2	0.23	0.24	0.22	0.26
	(0.30)	(0.30)	(0.30)	(0.83)
Year dummy (2006)	-0.07	-0.01	-0.08	-0.07
	(0.13)	(0.27)	(0.13)	(0.13)
Industry dummies	Included	Included	Included	Included
Constant	-0.60	-0.55	-0.61	-0.12
	(-0.17)	(-0.15)	(-0.18)	(-0.03)
Observations	717	717	717	717
Wald chi2	81.12	84.62	95.14	88.45

Notes: Robust standard errors in parentheses
*** significant at 1%, ** at 5%,* at 10% level